CSED490C

LAB 2

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Q3

1)

The only floating point operation in kernel code is `Cvalue += ds_A[ty][k] * ds_B[k][tx]`. There are two floating point operations in this line of code.

The matrices A and B are padded if they are not in multiples of `TILE_WIDTH`.

These padded cells have value of 0, but they are included in the calcuation for calculating the cell in Matrix C.

There are `TILE_WIDTH * ((numAColumnns - 1) / TILE_WIDTH + 1)` columns in padded matrix A and `TILE_WIDTH * ((numBRows - 1) / TILE_WIDTH + 1)` rows in padded matrix B. Let above values be `numPadAColumns` and `numPadBRows`, respectively.

Then for each cell in matrix C, there are `numPadAColumns * numPadBRows` executions of above line, which means that there are `2 * numPadAColumns * numPadBRows` floating point operations.

There are `numCColumns * numCRows` cells in matrix C, therefore there are `2 * numPadAColumns * numPadBRows * numCColumns * numCRows` floating point operations in the kernel code.

2)

Global byte read occurs when copying the input from host to device for matrices A and B. In total, there are `(numAColumns * numARows + numBColumns * numBRows) * sizeof(float)` bytes of global memory read.

3)

Global byte write occurs when copying result from device to host for matrix C. In total, there are `(numCColumns * numCRows) * sizeof(float)` bytes of global memory write.

4)

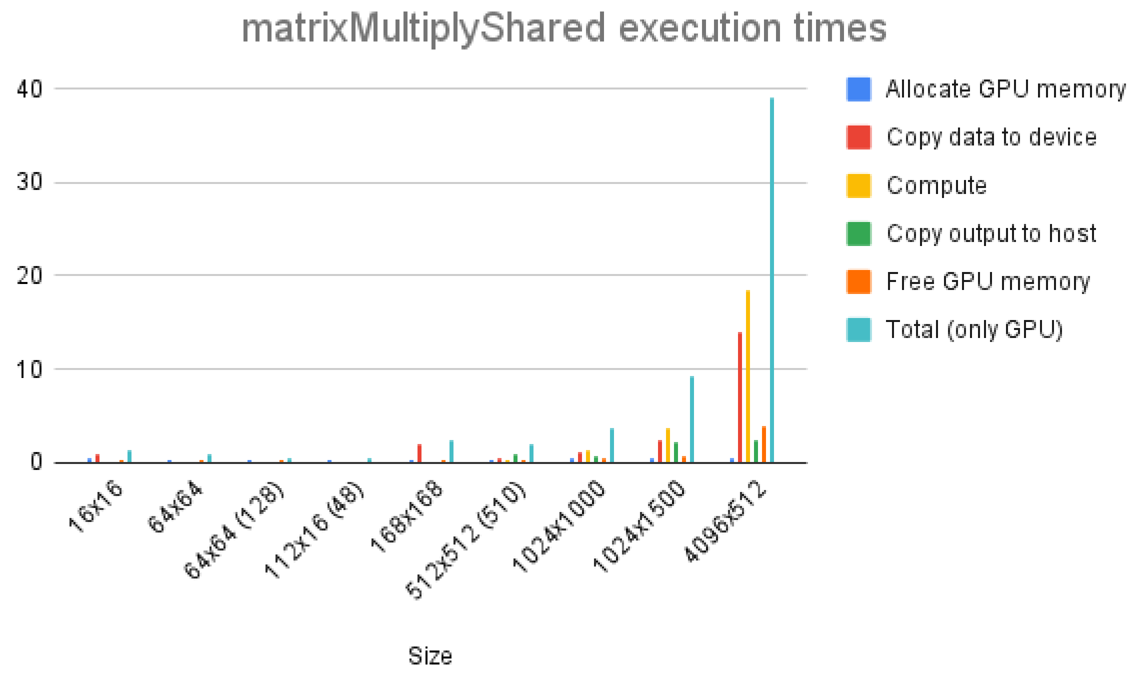
Streaming may be implemented to reduce the total running time by reading global memory while other threads are computing.

5)

`template.cu` is included in the assignment submission package.

6)

The execution was done on cse-edu cluster with `srun -p titanxp -N 1 -n 6 --mem=32G --gres=gpu:2 --pty /bin/bash -l` command with `TILE_WIDTH=32`.



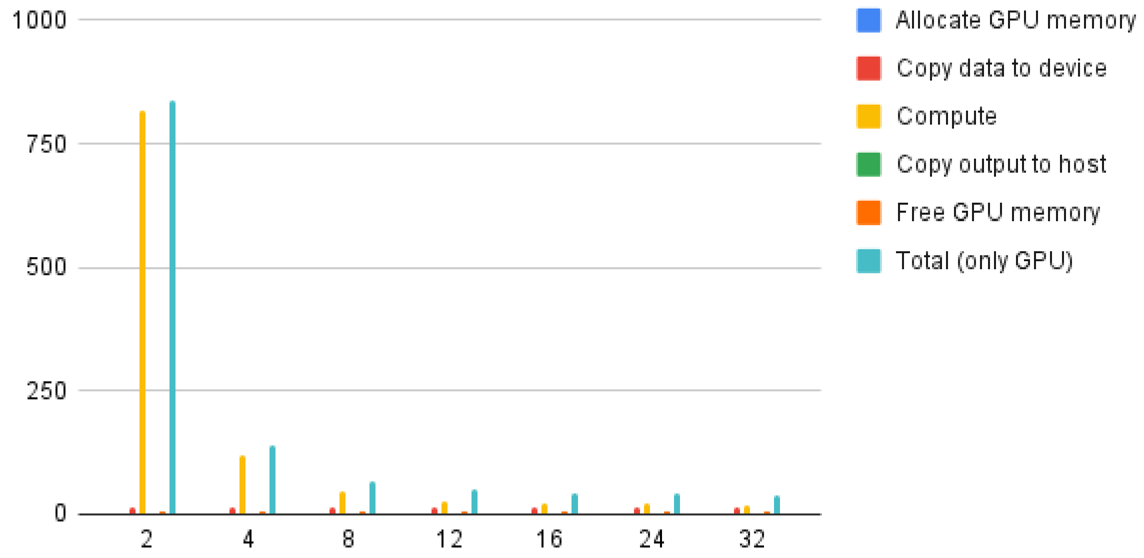
Raw Data Table

Test #	Size	Import data to host	Allocate GPU memory	Copy data to device	Compute	Copy output to host	Free GPU memory	Total (only GPU)	Total (including host)
0	16x16	2.63316	0.340406	0.781863	0.063505	0.030747	0.162312	1.378833	4.011993
1	64x64	8.10882	0.33477	0.109996	0.088691	0.048001	0.200229	0.781687	8.890507
2	64x64 (128)	8.05864	0.193213	0.079571	0.06082	0.033503	0.130919	0.498026	8.556666
3	112x16 (48)	3.86424	0.153312	0.057147	0.059008	0.023569	0.104529	0.397565	4.261805
4	168x168	28.5098	0.228024	1.8561	0.061205	0.079208	0.19957	2.424107	30.933907
5	512x512 (510)	177.778	0.278666	0.522663	0.186346	0.772894	0.204169	1.964738	179.742738
6	1024x1000 (1024)	406.057	0.380368	1.16741	1.23319	0.602947	0.385554	3.769469	409.826469
7	1024x1500 (2048)	1014.12	0.363002	2.31372	3.5711	2.20747	0.722436	9.177728	1023.297728
8	4096x512 (8000)	6720.79	0.461746	14.0161	18.4201	2.27539	3.98076	39.154096	6759.944096

7)

The exection was done on cse-edu cluster with `srun -p titanxp -N 1 -n 6 --mem=32G --gres=gpu:2 --pty /bin/bash -l` command.

Execution times of the kernel for 4096*8000 and 8000*512 input matrices with different tile widths



Raw Data Table

Test #	TILE_WIDTH	Import data to host	Allocate GPU memory	Copy data to device	Compute	Copy output to host	Free GPU memory	Total (only GPU)	Total (including host)
0	2	6630.84	0.456745	14.3715	815.646	2.08103	3.99529	836.550565	7467.390565
1	4	6598.7	0.459855	14.225	120.668	2.03641	3.97737	141.366635	6740.066635
2	8	6701.41	0.457706	14.1724	47.2746	2.25411	4.00314	68.161956	6769.571956
3	12	6660.54	0.467803	14.1007	25.8162	2.65672	7.38273	50.424153	6710.964153
4	16	6716.91	0.476233	14.1739	20.1227	2.61286	3.98701	41.372703	6758.282703
5	24	6439.52	0.440172	14.0728	20.5692	2.21944	3.99789	41.299502	6480.819502
6	32	6718.58	0.472083	14.211	18.4156	2.67518	3.98671	39.760573	6758.340573